PATENT SPECIFICATION

DRAWINGS ATTACHED

999,183

999,183

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Int. Cl.:—H 01 n

COMPLETE SPECIFICATION

A process for manufacturing Printed Circuits

I, JEAN MICHEL, a French citizen, of No. 14 Parc du Château Banquet, Geneva, Switzerland, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of printed circuits.

The printed circuits manufactured according to the present invention include conductors and various elements, for example capacitors and resistances. The invention provides new and useful printed circuits having metallic reinforcement of their base plates, which reinforcement serve also as electric screens.

The process of the present invention comprises printing a circuit pattern on an auxiliary conductive support, which circuit pattern includes a plurality of circuit elements, spaced apart from each other and connected to each other by conductors; bonding said auxiliary support on its circuit side to an insulating support; and subsequently chemically removing selected areas of that part of said auxiliary support which covers the circuit pattern, without attacking said circuit pattern; wherein the materials of the printed circuit pattern comprise at least two species of insulating, conducting or semiconducting substances selected from metals, metal oxides, carbon and dielectrics, the selected species being printed in succession; and wherein the unremoved part of the auxiliary conductive support which is bonded to the insulating support and does not cover any part of the pattern, except when forming a part of a capacitor, serves as an electrical screen and a mechanical reinforcement of the circuit assembly.

The process provides for dissolving the auxiliary support only partially, which is a great advantage. This can result in a considerable saving of expensive material, such as copper and nickel, by using inexpensive aluminum for the screens and mechanical reinforcements of the base plates. An aluminum sheet may initially serve as the auxiliary conductive support and is then partially dissolved, after having been adhesively bonded to an insulating support, at the places or areas covering the circuit elements. In this way the aluminum sheet is first used as an auxiliary support for printing the circuit pattern and thereafter as an electric screen and a mechanical reinforcement for the insulating support.

It is possible to combine several sub-circuits in a more or less complicated whole circuit. A complete printed circuit having the wiring, contacts, resistances, capacitors and a screen can be made by depositing and/or dissolving copper, nickel, aluminum, carbon (for high resistances) and dielectric layers (for capacitors). All these elements are printed or connected together without any soldering in known manner.

The process of the invention can be performed in the following manner: An aluminum sheet or foil is selected according to the requirements of the work to be carried out. Preferably sheet or foil is as thin as possible and may be reinforced by a detachable backing sheet such as paper to improve its strength or rigidity. The exposed surface of the sheet or foil is prepared, according to conventional methods, for electroplating, the question of adherence of the deposit playing practically no role. There is then outlined on the aluminum sheet or foil the negative of the desired circuit pattern. The negative may be outlined by any means known in the graphic art, for example, through a stencil or silk screen, etc. The copper is then deposited electrolytically in order to constitute the printed circuit.

It is possible to deposit separately by electrolysis not only copper but most of the usual metals, such as gold, silver, nickel, cadmium, chromium, rhodium and tin, as well as certain

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alloys. It is also possible to meet particular requirements, by building up a metallic deposit of a selected metal to a desired thickness, which built-up deposit becomes an integral part of the circuit. At this stage in the manufacture of the printed circuit all the components are metallic and, if desired, may be subjected to heat treatment without risk of being destroyed or spoilt. This is an advance over the known practice in which the circuit pattern is formed directly on an insulating support which may not be heat resistant and hence it would not be possible to subject the printed circuit pattern to heat treatment without risk of damaging the support.

Then there are deposited on the aluminum other materials in combination with the metallic circuit, for example carbon, graphite, metallic oxides, etc., which are deposited by precipitation, vaporization, fritting, etc. It thus becomes possible to fabricate directly in the circuit, resistors of preselected values.

The other circuit elements, such as capacitors, contacts and dielectric elements are applied to the aluminum sheet in the same manner or by any known technique.

The sheet or foil thus prepared is then coated with an adhesive on the printed circuit side and the surface of an insulating support is similarly prepared with adhesive. The two sticky surfaces are then applied one against the other and subjected to the action of heat and pressure according to the conditions required by the particular adhesive and insulating support. In some cases, the adhesion can be effected in the cold.

The backing sheet, if such is provided is then removed, and the exposed side of the aluminium sheet or foil, namely the side not carrying the printed circuit and not secured to the insulating support, is masked with a protective layer over those areas or places which do not register with the printed circuit and circuit elements.

The protective layer may be of any known kind, such as a film of a synthetic resin which is not attacked by the subsequent chemical treatment for removing the exposed aluminum.

The whole assemblage is finally dipped in a solution of 10% caustic soda at a temperature of 20° C. and this solution completely dissolves the unmasked aluminum, leaving the printed circuit elements and the protected aluminum adhered to the insulating support.

This process permits the gluing of a printed circuit under the same conditions of adherence as is known copper-coated laminates. The use of an auxiliary aluminum support permits its removal from those areas by dissolving in a solution of caustic soda, which does not attack copper or the other materials used for the printed circuit and circuit elements and avoids the use of engraving acids. In addition, the process provides the advantage of leading to an economy of copper, compensating largely for the small loss of aluminum, which is a metal currently much less expensive and which is easily obtained in rolls of large size.

The attached drawings shows an embodiment of the invention. In these drawings:

Fig. 1 shows schematically the electrical elements of a known bistable multivibrator;

fig. 2 shows the multivibrator (without the two transistors) of fig. 1, manufactured according to the process of the invention; and

figs, 3 to 8 show six steps of the manufacture of the multivibrator of fig. 2 respectively.

Referring to Fig. 1, this illustrates schematically the electrical elements of a conventional bistable multivibrator for generating rectangular oscillations. The multivibrator comprises resistances, capacitors, transistors (T_1 and T_2) and the appropriate wiring. Suitable voltage sources and input terminals are also provided. This type of multivibrator is well known in the art and needs no further explanation.

Fig. 2 shows the whole printed circuit of the multivibrator according to fig 1. This circuit is manufactured according to the process of the invention by several process steps, six of which are described in detail by means of figures 2 to 8.

Referring to fig. 3, an aluminum sheet is covered with a mask having five rectangular openings, through which five deposits of gold are made on the aluminum sheet by electrolysis. These five gold rectangles will serve as contacts.

The first mask is now removed and a mask according to fig. 4 is placed on the aluminum sheet. Copper is now deposited by electrolysis on the aluminum sheet through the openings of the second mask, whereby the wiring and two capacitors are obtained.

After the second mask has been removed, a third mask according to Fig. 5 is placed on the same aluminum sheet. Eight contacts as illustrated in Fig. 5 are deposited electrolytically through its openings. Gold or silver can best be used for this purpose.

The third mask is then removed and two dielectric films are placed on the structure at the places shown in Fig. 6. These dielectric films (d.f., Fig. 2) will serve as capacitor parts. Any known material suitable for dielectric film can be used, provided that it can be readily secured to the structure and that it can withstand the further manufacturing steps.

A fourth mask according to Fig. 7 is now placed on the structure obtained, and the resistances are deposited through its openings. These resistances may consist of either a suitable metal, such as *constantan*, deposited by electrolysis, or of carbon, deposited by any known printing method.

A sheet or plate of insulating material is now placed over and adhesively bonded to the surface of the aluminum carrying the printed circuit. The sandwich thus formed is turned over and a negative mask according to Fig. 8 is placed on the exposed surface of the aluminum sheet. The opening in this mask outlines the printed circuit so that by dissolving away, by treatment with sodium hydroxide solution, the unmasked area of the aluminum sheet, the printed circuit and surrounding marginal areas of the insulating sheet or plate are exposed. As can be seen from Figures 2 and 8, the printed circuit structure on the insulating plate *ip* is now surrounded on three sides by an aluminum sheet *AL*, which serves as a mechanical reinforcement for the insulating plate and also as an electrical screen for the multivibrator. The two strips of aluminum *SL* visible in figures 2 and 8 each constitute a part of the two 300 pF capacitors.

At places T_1 and T_2 five holes are provided in the usual manner, so that the two transistors can be properly connected to the printed circuit.

It is obvious that the material for the insulating plate, the dielectric film and the adhesives are selected from known materials capable of withstanding every step of the manufacture. Materials which cannot withstand treatment with a 10% sodium hydroxide solution cannot therefore be used However there are a great number of suitable materials shown, and it will be within the realm of those skilled in the art to select the proper materials from the multitude of known substances for the purpose indicated It is also clear that some or all of the masks need not be removed, provided that they do not hinder the subsequent process steps.

The various circuits or combinations of circuits can, by appropriate choice of various elements or adhesives, be applied on material such as Bakelite [Bakelite is a Registered Trade Mark], epoxy resins, melamine, glass, steatite, ceramic, and on flexible films such as paper, polyvinyl chloride, glass fabrics, etc. The circuits can likewise be coated with, or embedded in suitable material and glued on plastic, rubber or cellulose materials.

In the above described process, the imprinting of the circuit on the auxiliary conductive support can be carried out with the aid of an electric current, i.e. by electroplating, or without current by chemical replacement between two solutions. In the last case there can be used, for example, the replacement of the metal content in a solution of copper sulphate with the aid of a light coating of iron preliminarily deposited by treatment of the conductive support by means of a solution containing iron perchloride.

WHAT I CLAIM IS:—

1. A process of manufacturing a printed circuit assembly comprising printing a circuit pattern on an auxiliary conductive support, which circuit pattern includes a plurality of circuit elements, spaced apart from each other and connected to each other by conductors; bonding said auxiliary support on its circuit side to an insulating support; and subsequently chemically removing selected areas of that part of said auxiliary support which covers the circuit pattern, without attacking said circuit pattern; wherein the materials of the printed circuit pattern comprise at least two species of insulating, conducting or semiconducting substances selected from metals, metal oxides, carbon and dielectrics, the selected species being printed in succession; and wherein the unremoved part of the auxiliary conductive support which is bonded to the insulating support and does not cover any part of the pattern, except when forming a part of a capacitor, serves as an electrical screen and a mechanical reinforcement of the circuit assembly.

2. A process for manufacturing printed circuits substantially as described hereinbefore.

3. A printed circuit assembly manufactured by a process according to any preceding claim.

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999183 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

FIG.1

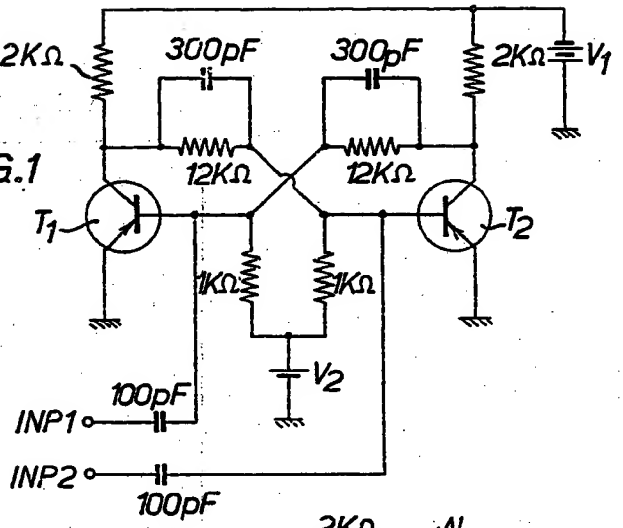


FIG.2.

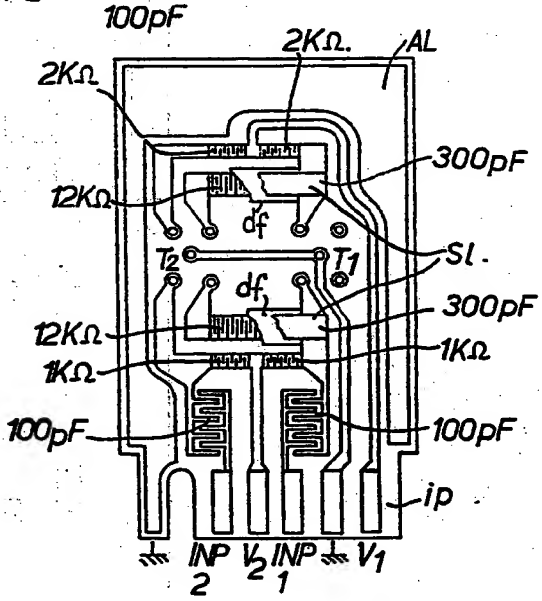


Fig. 3.

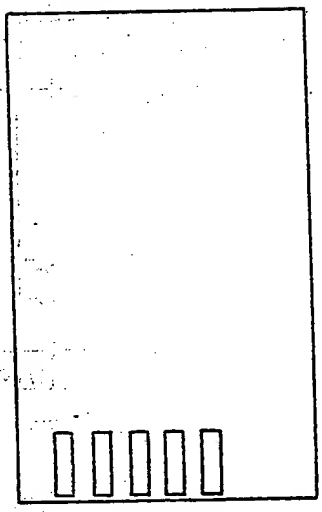


Fig. 4.

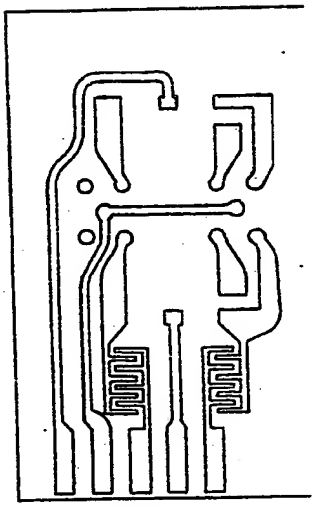


Fig. 5.

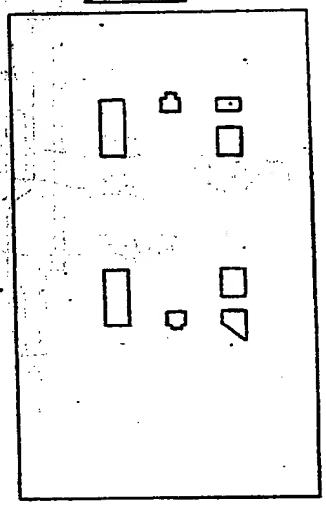
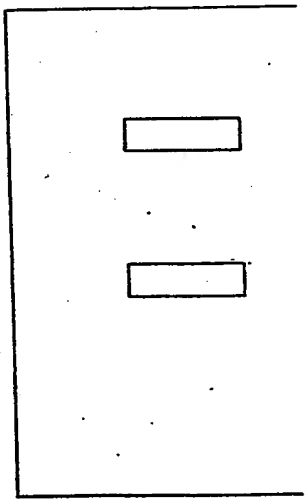


Fig. 6.



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Sheets 2 & 3

Fig. 4.

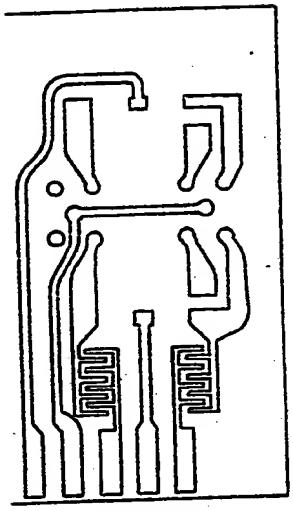


Fig. 6.

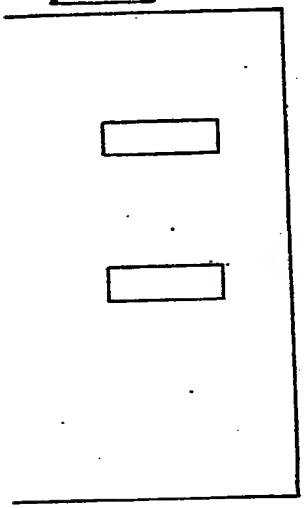


Fig. 7.

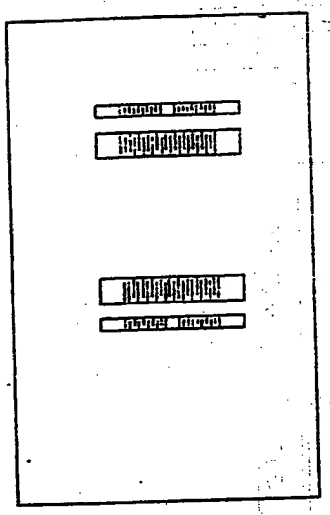
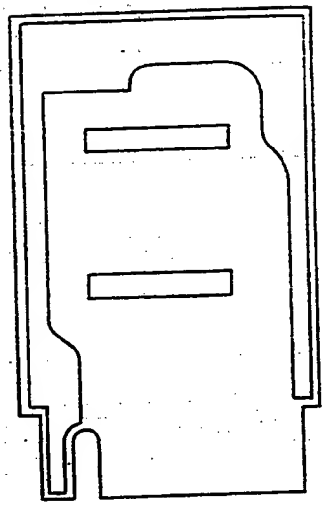


Fig. 8.



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Sheets 2 & 3

FIG. 3.

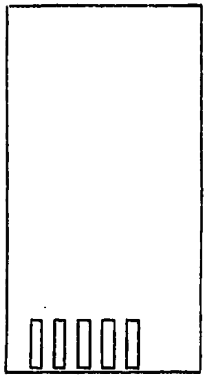

FIG. 4.

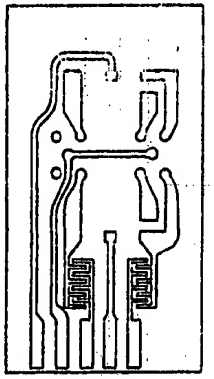

FIG. 5.

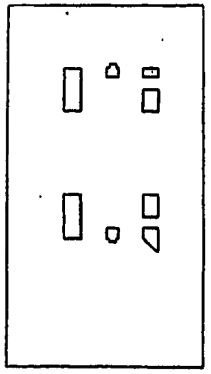

FIG. 6.

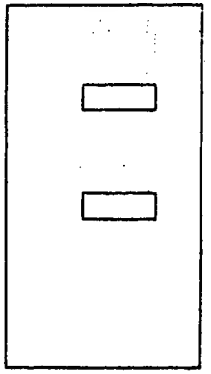

FIG. 7.

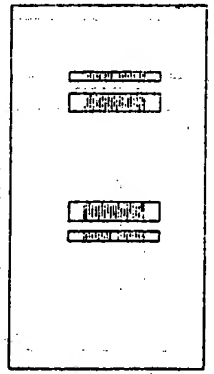

FIG. 8.